ON A COLLECTION OF LINGUATULIDS IN THE LIVERPOOL SCHOOL OF TROPICAL MEDICINE

BY

T. SOUTHWELL

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The only feature of interest in this collection is the occurrence of several species of Linguatulids in fresh hosts and in new localities, the most important being the presence of *Porocephalus clavatus* in African snakes.

An attempt had been made to provide a key for all the known genera and species, but in the absence of adequate descriptions of numerous species the result is somewhat unsatisfactory. The keys are compiled from the descriptions given by Shipley and by Sambon in their respective papers, and the definitions of the various genera, sections, etc., are after Sambon. The only species I have been able to examine are pointed out in the text.

Except where otherwise stated, the measurements given refer to females only.

The Linguatulids are parasitic worm-like animals which are annulated in such a way that they resemble segmented worms. The annulations are, however, purely superficial for there is no segmentation of the genital organs such as exist in the Cestoda.

The systematic position of this family of parasites in the animal world is a matter on which some doubts exist, but the generally accepted opinion is that they are an aberrant, or degenerate branch of the Phylum Arthropoda and of the class ARACHNIDA (scorpions, spiders, etc.) and of the Order **Acarina** (mites and ticks) *i.e.*, that they are more or less related to ticks and mites, even though superficially they are worm-like in appearance. The limbs are represented by four hooks which encircle the mouth ; the muscle fibres are striated. Respiratory, circulatory and special sense organs are absent. The gut is a simple tube with no appendages ; the sexes are separate as in other Acarines and there is a small nerve ring which surrounds the oesophagus.

The synonymy of the parasites included in this family is very extensive. Frölich, in 1789, erected the genus *Linguatula* and included in it the species *serrata*. Humboldt (1811) established the genus *Porocephalus* to accommodate *P. crotali*. Rudolphi (1819) placed the species *taenioides, denticulatum, serratum, emarginatum* and *proboscideum* in a new genus which he named *Pentastomum*.

Within recent years the worms have been variously referred to as Linguatulids, Pentastomes and Porocephalids. It will be clear that the name Linguatula has priority, and this name is now used to designate the family.

Sambon (1922) defines the family LINGUATULIDAE as follows :—

'Blood sucking, endoparasitic *Acarina*. Body legless, elongate, vermiform, and more or less markedly annulated. Mouth round, squarish, or elliptical, provided with a chitinous armature of varied structure, and situated either before, behind or between two pairs of hollow, retractile, fang-like chitinous hooks emerging from four longitudinal pits or pouches disposed in trapezoidal formation or archwise. These hooks may be either equal or unequal, smooth or serrated, single or binate. Anus terminal or sub-terminal. Sexes divided ; female larger than male. Genital opening on mid-ventral line ; at anterior end of abdomen in male ; either at anterior or posterior end of abdomen in female. When at posterior extremity, the latter opens more or less near anus, but always anterior to it. The ovary is a long, dorsally-placed organ, usually extending almost the whole length of the abdomen. Anteriorly it divides into two oviducts, which bestride the alimentary canal, pass the spermathecae, receive the spermathecal ducts, and unite, forming either a wide egg-sac or a long tube, which combines the functions of both uterus and vagina. When tubular, the utero-vagina runs in a straight line to the posterior end in the virgin and permits copulation, but becomes greatly elongated in the gravid female, forming numerous and complex gyrations. Its coils may be amassed either above or below the alimentary canal, or they may be twined around it. Accordingly, the alimentary tube is either dorsal, ventral or axial. These anatomical details are given here because of their taxonomic importance. They are usually discernible in fully distended females owing to the transparency of the integument, but, in any case, they may be easily detected after clarification by the usual methods.

'The eggs are enclosed in a thin, bladder-like envelope filled with an albuminous substance clear as glass, and contain within their thick chitinous shell an oval embryo with rudimentary mouth parts and either six or four legs, each one tipped with two strong, claw-like hooks. On the back of the embryo may be seen the so-called dorsal organ or facette.'

Adult Linguatulids, although they occur occasionally in the gut or body cavity, are parasitic principally in the lungs of reptiles and in the frontal sinus and maxillary antra (connected with the nasal chambers) of the dog, the wolf and occasionally in man. They occur less rarely in birds and amphibians.

The larvae occur in animals which are preyed upon by the host in which the adult parasite lives.

In *Linguatula serrata* the eggs are passed in the discharge from the mouth and nostrils; they also occur in the faeces; each egg contains an embryo; when swallowed by the intermediate host the egg-shell is dissolved and the larva is liberated; the larva then bores its way to the liver, spleen, etc., and, after a series of moults it encysts, grows, and becomes a nymph. When this nymph is swallowed by the final host it makes its way from the gut to the lungs or the nasal cavities where it becomes adult; the nymph, when fully developed, is said to be able to leave the cyst and to migrate to the bronchi or to the intestine of the intermediate host, from which positions it is passed to the exterior. It reaches its final host by being sniffed up by the dog and becomes adult in the nasal cavities. It is also probable that, occasionally, the entire life-history is passed in one host.

Sambon (1922), in his Synopsis of the family LINGUATULIDAE, Parts I and II, classified the family as follows :—

Family LINGUATULIDAE, Shipley, 1898.

Sub-family 1. RAILLIETIELLINAE, Sambon, 1922.
Genera. *Raillietiella*, Sambon, 1910.
Reighardia, Ward, 1899.

Sub-family 2. POROCEPHALINAE, Sambon, 1922.

Section. *SEBEKINI*, Sambon, 1922.
Genera. *Sebekia*, Sambon, 1922.
Alofia, Giglioli, 1922.
Leiperia, Sambon, 1922.
Sambonia, Noc and Giglioli, 1922.
Diesingia, Sambon, 1922.

Section. *POROCEPHALINI*, Sambon, 1922.
Genera. *Porocephalus*, Humboldt, 1811.
Kiricephalus, Sambon, 1922.
Armillifer, Sambon, 1922.
Waddycephalus, Sambon, 1922.

Section. *LINGUATULINI*, Sambon, 1922.
Genera. *Linguatula*, Frölich, 1789.
Subtriquetra, Sambon, 1922.

KEY TO THE SUB-FAMILIES OF THE FAMILY LINGUATULIDAE.

Female genital opening anterior; mouth anterior to hooks. Salivary glands moderately developed; Larvae with six short legs..... *Raillietiellinae*

Female genital opening posterior; mouth in line with or posterior to hooks; salivary glands greatly developed. Larvae with four legs..... *Porocephalinae*

Sub-family I. RAILLIETIELLINAE, Sambon, 1922.

Diagnosis.—LINGUATULIDAE :

'Female genital opening at anterior end of abdomen. Utero-vagina straight, ample, sacciform. Mouth anterior to hooks. Salivary glands moderately developed. Larva with six, short, stumpy legs.'

Genus *Reighardia*, Ward, 1899.

Diagnosis.—RAILLIETIELLINAE :

'Body cylindrical, elongate, slightly attenuated at both ends. Integument covered with stud-like projections. Mouth in advance of hooks. Hooks exceedingly minute, placed in trapezoidal formation. Posterior extremity bluntly rounded and curved ventrally.

'Only one species known from Holarctic region. Adult form parasitic in air sac of Gulls and Terns (*Laridae*). Nymphal form probably encysted in fish.

'Type species : *Reighardia sternae* (Diesing, 1864), Ward, 1899.'

No specimens belonging to this genus were found in the collections of the Liverpool School of Tropical Medicine.

Genus *Raillietiella*, Sambon, 1910.

Diagnosis.—RAILLIETIELLINAE :

'Body cylindrical, long, slender, flattened ventrally, tapering at both ends. Integument smooth, transparent. Mouth well in advance of hooks; opens on a terminal projection. Hooks simple, unequal, placed in trapezoidal formation; anterior pair smaller than posterior. Three vesicular projections about each hook, one anterior, globular, ensheathing the hook, the other two hemispherical, one on each side. Two vesicular projections placed dorsally on each side of cephalothorax, on a level with anterior pair of hooks. Posterior extremity bifid; terminal lobes divergent. Anus between terminal lobes.

'Six species described from Oriental, Ethiopian and Neotropical regions. Adult form parasitic in *Ophidia*, *Lacertilia* and *Bufonidae*.

'Type species : *Raillietiella boulengeri*, Vaney and Sambon, 1910.'

KEY TO GENERA AND SPECIES OF THE SUB-FAMILY RAILLIETIELLINAE.

Hooks exceedingly minute without vesicular projections; posterior extremity bluntly rounded..... *Reighardia* with one species only, viz., *R. sternae*

Hooks each with three vesicular projections; posterior extremity bifid, terminal lobes divergent..... *Raillietiella*

KEY TO SPECIES OF THE GENUS RAILLIETIELLA.

1. Each hook bears one or two stylets on its inner surface, close to base ..... *R. geckonis*
   Stylets absent 2
2. Worms with over 38 annuli 6
   Worms with less than 38 annuli 3
3. Small worms under 8 mm. in length ..... *R. indica*
   Worms over 8 mm. in length 4
4. None of the hooks are borne on parapodia ..... *R. boulengeri*
   Either one or both pairs of hooks are borne on parapodia 5
5. Posterior pair of hooks borne on long parapodia ..... *R. mabuiae*
   Both pairs of hooks borne on long parapodia ..... *R. tetrapoda*
6. Body of female spirally coiled ..... *R. spiralis*
   Body of female not spirally coiled ..... *R. furcocerca*

As I have been unable to discover any morphological differences between the following species they are considered identical, viz.,

R. furcocerca.
R. furcocerca, var. *orientalis* and
R. furcocerca, var. *mediterranea.*

Raillietiella furcocerca (Diesing, 1835), Sambon, 1910.

SYNONYMS :—*Pentastoma furcocercum*, Diesing, 1835.
Pentastomum bifurcatum, Diesing, 1850.
Porocephalus bifurcatus, Shipley, 1898.

One damaged specimen of what appears to be this species, obtained from the pericardial region of a Colubrine snake in Southern Nigeria (February, 1915), was presented by Dr. J. F. Corson.

Raillietiella boulengeri, Vaney and Sambon, 1910.

SYNONYM :—*Porocephalus boulengeri*, Vaney and Sambon, 1910.

Three densely gravid females from *Causus rhombeatus*. Accra, January, 1915. Collected and presented by Dr. J. W. S. Macfie.

Sub-family II. POROCEPHALINAE, Sambon, 1922.

Diagnosis.—LINGUATULIDAE :

'Female genital opening at posterior end of abdomen. Utero-vagina tubular, greatly elongated and forming numerous windings. Mouth in a line with, or posterior to, hooks. Salivary glands greatly developed, extending whole length of body on either side of alimentary tube. Larva with four legs.'

KEY TO SECTIONS OF THE SUB-FAMILY POROCEPHALINAE.

	Body flattened	*Linguatulini*
	Body cylindrical....1	
1.	Well-marked latero-ventral grooves; hooks in trapezoidal formation	*Sebekini*
	Latero-ventral grooves absent; hooks disposed archwise	*Porocephalini*

Section I. *Sebekini*, Sambon, 1922.

Diagnosis.—POROCEPHALINAE :

'Body cylindrical. Well-marked latero-ventral grooves. Hooks in trapezoidal formation. Alimentary canal dorsal, longer than body, sinuous.

'Type genus : *Sebekia*, Sambon, 1922.'

KEY TO GENERA OF THE SECTION SEBEKINI.

	Female genital pore on fifth ring from posterior extremity	*Sambonia*
	Female genital pore on terminal ring....1	
1.	Worms more or less spirally coiled	*Leiperia*
	Worms not spirally coiled....2	
2.	Convex surface of hooks serrated	*Sebekia*
	Convex surface of hooks not serrated....3	
3.	Body capsicum-shaped. Annulations limited to ventral surface	*Diesingia*
	Body not capsicum-shaped. Annulations complete	*Alofia*

Genus *Alofia*, Giglioli, 1922.

SYNONYMS :—*Pentastomum*, Lohrmann, 1889.
Porocephalus, Shipley, 1898.
Reighardia, Sambon, 1910.

Diagnosis.—*Sebekini :*

'Body small, massive, banana-shaped. Cephalothorax large, continuous with abdomen. Annuli 70-75. Mouth U-shaped, very large, with posterior margin on posterior hook-line and anterior end above anterior hook-line. Hooks comparatively large, single, equal and smooth. Alimentary tube largely sinuous. Utero-vagina ventral, convoluted. Anus terminal. Genital opening contiguous.

'One valid and two doubtful species described. Two from Samoa, the third unknown locality. Hosts unknown, probably fish.

'Type species : *Alofia ginae*, Giglioli, 1922.'

Four species of this genus have been recorded, but at present it is not possible to prepare a key to the species as the details relating to them are so scanty. No species of the genus occurs in the

collection of the Liverpool School of Tropical Medicine. The principal details relating to the four species are as follows :—

Table I.

	Length	No. of annuli	Remarks
A. ginae ...	15 to 20 mm. × 2 to 3 mm.	75	Chitinous oral armature U-shaped.
A. merki ...	15 mm. × 3 mm.	75	
A. platycephala	23 mm. × 2.8 mm.	70	
A. adriatica ...	21 mm. to 85 mm.	72	Chitinous oral armature, key-shaped.

Genus *Sebekia*, Sambon, 1922.

Synonyms :—*Pentastoma*, Rud., 1819 (in part).
Pentastomum, Diesing, 1835.
Porocephalus, Stiles, 1893.
Reighardia, Sambon, 1910.

Diagnosis.—Sebekini :

'Body small, massive, closely annulated (annuli c. 80). Cephalothorax very small, wedge-shaped, projecting nipple-like from gross abdomen, ventral side continuous with that of abdomen. Mouth subterminal, shaped more or less like an inverted U, with free ends approximated. Hooks very small, distance between anterior and posterior hook-lines small. Hooks single, equal with convex surface serrated. Alimentary canal longer than body, forming sinuous loop about junction of anterior with medium third of body. Anus terminal. Utero-vagina long, much convoluted, amassed beneath alimentary tube. Ovary sinuous. Genital opening slightly anterior to anus.

'Six species described from Oriental, Ethiopian, Neotropical and Australasian regions. Adult forms parasitic in Crocodilians and Monitors. Nymphal forms probably in fish.

'Type species : *Sebekia wedli*, Giglioli, 1922.'

The details relating to the six species placed in this genus are so meagre that it is impossible to prepare a key. The principal point of differentiation between the species is said by Sambon to be the form of the chitinous oral armature surrounding the mouth. No species belonging to this genus were found in the collections of the Liverpool School of Tropical Medicine.

The following are the principal points relating to the six species described :—

Table II.

	Length	No. of annuli	Remarks
S. oxycephala ... ... ? = *P. crocodili*, Wheeler ...	10 mm.	60	
S. divestei	10 mm.	75	
S. wedli	10 to 25 mm.	80	
S. cesarisi	15 mm. × 2 mm.	Not known	Each annulus bears a pair of digitate processes.
S. indica	24 mm. × 5 mm.	Not known	
S. jubini	42 mm. × 4.5 mm.	Not known	

Genus *Sambonia*, Noc and Giglioli, 1922.

Diagnosis.—Sebekini :

'Body incurved, tapering at both ends. Annulations (44 in type sp.), slightly imbricative, giving the body outline a serrated appearance. Cephalothorax small, wedge-shaped. Mouth and hooks close to anterior border. Mouth ovate, placed between hook lines with longest diameter vertical. Hook-trapezoid, low and relatively wide at base. Hooks simple, smooth, equal. Anus terminal. Female sexual opening above terminal segment (fifth ring from posterior end in type sp.). Ova with strikingly characteristic spined outer shell. Parasite of Lizards.

'Type species : *Sambonia lohrmanni* (Sambon, 1910), Noc and Giglioli, 1922.'

Key to Species of the Genus Sambonia.

	Length	Annuli
S. lohrmanni	13 to 17 mm. × 3 mm.	44
S. wardi	75 to 150 mm.	44

No specimens of this genus were found in the collections of the Liverpool School of Tropical Medicine.

Genus *Leiperia*, Sambon, 1922.

Diagnosis.—Sebekini :

'Body large, cylindrical, elongate, more or less spirally coiled. Hooks in trapezoidal formation, simple, equal, smooth. Distance between hook-lines relatively great. Mouth small, situated on posterior hook-line. Utero-vagina beneath slightly sinuous alimentary tube. Posterior extremity tapering somewhat at the very end. Anus terminal. Female genital opening slightly anterior to anus.

'One species from Nilotic Crocodile (*Crocodilus niloticus*).

'Type species : *Leiperia cincinnalis* (Sambon, 1910), Sambon, 1922.'

The genus *Leiperia* contains one species only, viz., *L. cincinnalis*.

Leiperia cincinnalis, Sambon, 1922.

Very numerous young, adult, male and female specimens, all immature, from the lung of a crocodile. Upper Shire, Nyasaland. Collected by Professor R. Newstead, F.R.S., and Dr. Davey, in 1911.

The specimens measured from 35 mm. to 50 mm. in length and from 1 mm. to 1·3 mm. in breadth; the number of annuli varied from about 90 to 110. The female genital pore is situated on the last segment, slightly in front of the anus. The hooks are bifurcated, the larger branch measuring 212μ and the smaller 150μ in length. In the mature adult the hooks are simple.*

Genus *Diesingia*, Sambon, 1922.

Diagnosis.—Sebekini:

Body capsicum-shaped, the annulations being limited to the ventral surface; a median ventral groove is present.

Type species.—D. kachugensis (Shipley, 1910).

Sambon (1922) erected the genus *Diesingia* to accommodate *Porocephalus kachugensis*, Shipley, 1910, a capsicum-shaped nymph in which all the four hooks are bifid; it measured 12 mm. in length and 3 mm. in breadth, and had from 40 to 46 annuli; from *Kachuga lineata*, India.

Hett is of opinion that *D. kachugensis* is the larval form of *Subtriquetra megacephala* (Baird) and that, on account of its shape, etc., the latter species is intermediate between the genera *Linguatula* and *Subtriquetra*. If such proves to be the case then Baird's species will have to be referred to the genus *Diesingia*, and the latter genus to Sambon's section *Linguatulini*.

Section II. *Porocephalini*, Sambon, 1922.

Diagnosis.—Porocephalinae:

'Body cylindrical. No latero-ventral grooves. Hooks disposed archwise. Alimentary canal dorsal or axial, not longer than body, straight.

'Type genus: *Porocephalus*, Humboldt, 1811.'

* A number of smaller specimens of this species have since been obtained from 'a large fish,' Tanganyika.

KEY TO GENERA OF THE SECTION POROCEPHALINI.

The outer pair of hooks are bifurcated..... *Porocephalus*
Outer pair of hooks not bifurcated..... 1

1. Annulations marked by prominent bands giving the worm a beaded appearance..... *Armillatus*
Annulations not prominent.....2

2. Female pore opening considerably anterior to anus..... *Waddycephalus*
Female pore terminal..... *Kiricephalus*

Genus *Porocephalus*, Humboldt, 1811.

SYNONYMS :—*Echinorhynchus*, Humboldt, 1808.
Distoma, Humboldt, 1808.
Polystoma, Rudolphi, 1812.
Pentastoma, Rudolphi, 1819.
Linguatula, van Beneden, 1849.
Pentastomum, Diesing, 1850.

Diagnosis.—Porocephalini :

'Body club-shaped ; posterior half curved more or less ventrally ; terminal segments dilated into characteristic olive-shaped enlargement. Annuli smooth. Cephalothorax bluntly rounded anteriorly. Hooks unequal ; inner simple, outer provided with non-caducous accessory spine ; disposed in slightly arcuate line with convexity posterior. Mouth ovate, placed on inner hook-line. Anus subterminal. Female genital opening placed on terminal segment anterior to, and continuous with, anus. Alimentary canal axial, short, straight. Utero-vagina twined around alimentary tube. Four valid species described from Ethiopian and Neotropical regions. Adult forms parasitic in Ophidians ; nymphal forms encysted in mammals. Probably attacks man also.

'Type species : *Porocephalus crotali*, Humboldt, 1811.'

KEY TO SPECIES OF THE GENUS POROCEPHALUS.

Over 70 annuli..... *P. crotali*
Less than 70 annuli.....1

1. Annuli quite distinct.....2
Annuli indistinct and from 1 to 2 mm. apart..... *P. subulifer*

2. With 35 to 43 annuli..... *P. clavatus*
With 45 to 50 annuli..... *P. stilesi*

It should be noted here that the identity of *P. crotali*, Humboldt, is not definitely established. Hett (1924, pp. 141-144) discusses the question at some length. Humboldt obtained the species from a rattlesnake (*Crotalus cumanensis*) but did not state how many annuli the worm possessed. Diesing (1835 and 1850) described this and several other species under the name *Pentastomum proboscideum*, including one form from a boa and another only recorded hitherto from *Lachesis* spp. According to Diesing, the number of annuli is 80, but in his figures a varying number are shown. Leuckart examined Diesing's material

and stated that the worms possessed only about 40 annuli. Sambon accepts Diesing's statement that *P. crotali* has 80 annuli, but Hett (1924) agrees with Leuckart, and describes *P. crotali* as possessing about 40 annuli.

Porocephalus clavatus (Wyman, 1845), Sambon, 1910.

Synonyms :—Adult : *Linguatula clavata*, Wyman, 1847.
Linguatula proboscidae, van Ben., 1849, in part.
Pentastomum proboscideum, Leidy, 1856, in part.
Pentastomum clavatum, Leuckart, 1860.
Pentastomum imperatoris, Macalister, 1875.
Pentastoma moniliforme, Mégnin, in part.
Nymph : *Pentastomum didelphidis virginianae*, Leidy, 1852.

Specimens were obtained from the following sources :—(1) Two gravid females from a snake (genus and species unknown) : Leverville, Congo, October, 1923 ; collected by Dr. Brassart. (2) One specimen from a snake ; species and locality unknown. (3) Three specimens from a snake (*Causus rhombeatus*) : Gold Coast, September, 1915 : collected and presented by Dr. Corson.

This species has hitherto only been recorded from *Boa constrictor* and *Boa imperator*.

Most species of true boas inhabit the warmer parts of Central and Southern America, but two species occur in Madagascar.

Porocephalus subulifer (Leuckart, 1860), Stiles, 1893.

Synonym :—*P. cercopitheci*, Breinl and Hindle, 1908.

Several specimens from the lung of a Green Guenon (*Cercopithecus callitrichus*).

Genus *Kiricephalus*, Sambon, 1922.

Synonyms :—*Pentastomum*, Diesing, 1850.
Porocephalus, Shipley, 1898.

Diagnosis.—Porocephalini :

' Body club-shaped (like the Kaffir " kiri " and other knobbed clubs, sometimes armed with spikes), greatly elongate, of uniform thickness throughout and spirally twisted on its own axis. Annuli smooth. Cephalothorax more or less globular, owing to the constriction of anterior body rings brought about by habit of inserting cephalothorax deeply into host's lung. Hooks slightly unequal in size, but simple, without accessory spines. Mouth ovate, placed just below inner hook-line. Anus sub-terminal. Female sexual opening placed on terminal segment, somewhat anterior to anus. Alimentary canal axial ; on account of body torsion, appears to twine around utero-vaginal skein.

'Three valid species described from Oriental, Neotropical and Australasian regions. Parasitic in Ophidia.

'Type species : *Kiricephalus coarctatus* (Diesing, 1850), Sambon, 1910.'

Key to Species of the Genus Kiricephalus.

	Length	Annuli
K. coarctatus	... 76 to 115 × 4 mm.	52
K. pattoni	... 80 to 115 × 2·5 mm.	36
K. tortus	... 40 mm.	25

Kiricephalus pattoni (Stephens, 1908), Sambon, 1922.

Synonym :—*Porocephalus pattoni*, Stephens, 1908.

The type specimens of this species from *Zamenis mucosus* are in the collections of the Liverpool School of Tropical Medicine. (1) Four females and one male were also obtained from a snake (species unknown) : Hong Kong ; presented by Dr. Bell. (2) Two females and one male from *Zamenis mucosus :* Zoological Gardens, Calcutta ; presented by Captain Knowles, I.M.S., 27.3.1923.

Genus *Armillifer*, Sambon, 1922.

Synonyms :—*Pentastoma*, Diesing, 1835.
Linguatula, Wyman, 1847.
Nematoideum, Diesing, 1851.
Pentastomum, Harley, 1856.
Porocephalus, Stiles, 1893.

Diagnosis.—Porocephalini :

' Body cylindrical, elongate, slightly curved ventrally ; terminal segment conical. Annulation strongly marked by thick, prominent bands in each segment, giving the species of this genus a beaded or ringed window-pole appearance. Cephalothorax wedge-shaped, with anterior border rounded. Hooks robust, equal, simple ; placed in straight or slightly arcuate line. Mouth orbicular, placed just above inner-hook line. Anus terminal. Female genital opening on terminal segment, somewhat anterior to anus. Alimentary tube dorsal, short, straight. Utero-vaginal coils amassed beneath alimentary tube. Three valid species described from Ethiopian and Oriental regions.

' Adult forms : Parasitic in Ophidia, nymphal forms in mammals and birds.

' Type species : *Armillifer armillatus* (Wyman, 1847), Sambon, 1922.'

Key to Species of the Genus Armillifer.

With a neck-like constriction between cephalothorax and body 3
Neck-like constriction absent 1
1. With 28 to 35 annuli ..... *A. moniliformis*
With less than 28 annuli 2
2. With two small papillae in front of mouth ..... *A. armillatus*
With a single small lobe in front of mouth ..... *A. grandis*
3. Neck about 1 mm. in length ..... *A. annulatus*
Neck 5 to 7 mm. in length ..... *A. pomeroyi*

Sambon considers that *Porocephalus pomeroyi*, Woodland, is identical with *A. annulatus;* but Hett believes them to be distinct species and gives a table showing the differences between the two forms.

Armillifer moniliformis (Diesing, 1835).

Synonyms :—Adult : *Pentastoma moniliforme*, Diesing, 1835.
Pentastoma moniliforme, Leuckart, 1860.
Linguatule moniliforme, Mégnin, 1880.
Porocephalus moniliformis, Stiles, 1893.
Nymph : *Pentastomum tornatum*, Creplin, 1849, in part.
Pentastomum aonycis, Macalister ,1874.
Porocephalus armillatus, Stiles, 1908, in part.

Five female specimens (gravid) from *Tropidonotus picturatus*, Darwen, Northern Territory, Australia. Presented by Dr. P. A. Maplestone, D.S.O., M.B., Ch.B., Australia.

The adult form has hitherto only been recorded from the Indian python which inhabits India, Ceylon and Indo-China.

Armillifer armillatus (Wyman, 1847), Sambon, 1922.

Synonyms :—Adult : *Linguatula armillata*, Wyman, 1847.
Pentastomum polyzonum, Harley, 1856.
Pentastomum amillatum, Leuckart, 1860 (misprint).
Pentastoma armillata, Wyman, 1863.
Pentastomum armillatum, Diesing, 1864.
Porocephalus armillatus, Stiles, 1893.
Porocephalus polyzonus, Stiles, 1893.
Porocephalus moniliformis, Neumann, 1899 (in part).
Nymph : *Linguatula diesingii*, van Ben., 1849.
Pentastomum tornatum, Creplin, 1849 (in part).
Pentastomum euryzonum, Diesing, 1850.
Nematoideum hominis (*viscerum*), Diesing, 1851.
Pentastomum constrictum, Von Siebold, 1852.
Linguatula constricta, Küchenmeister, 1855.
Pentastoma leonis, Wedl, 1863.
Pentastomum leonis, Diesing, 1864.
Pentastoma tornatum, Cobbold, 1879.
Pentastomum protelis, Hoyle, 1883.
Porocephalus constrictus, Stiles, 1893.
Linguatula constrictor, Galli Valerio, 1896 (misprint).
Pentastomum diesingii, Shipley, 1898.

Specimens were examined from the following sources :— (1) Several nymphs from spleen, lungs, liver, etc., of man : Freetown, Gold Coast, West Africa ; collected by Dr. S. Adler, 18.12.1923. (2) Four specimens, nymphs, from liver of man ; presented by Dr. Manuk, Lokoja. (3) Two specimens from a dead prisoner ;

presented by Dr. J. Hannington, M.O., Nigeria. (4) Six specimens, immature adults, from a Kroo Boy : Degama, Gold Coast, July, 1913 ; Dr. H. A. Wilson ; collected and presented by Dr. J. W. S. Macfie. (5) Two nymphs from man, Akoada District, E.P. Nigeria, 13.9.13. ; collected by Dr. H. A. Wilson and presented by Dr. J. W. S. Macfie. (6) One nymph from man : Accra, Gold Coast ; collected by Dr. Findley, and presented by Dr. J. W. S. Macfie. (7) Several nymphs from liver of man, and one from mesentery : Accra, Gold Coast ; collected and presented by Dr. J. W. S. Macfie. (8) Several nymphs from man : Accra Gold Coast, October 15, 1916 ; collected and presented by Dr. J. W. S. Macfie. (9) Two specimens from the peritoneal cavity of a chimpanzee ; presented by Mr. Walker, 22.12.06. (10) One gravid female from a pig's liver : Accra, Gold Coast ; collected and presented by Dr. J. W. S. Macfie, 12.3.1923. (11) Three nymphs from liver of an ox : Accra, Gold Coast ; collected and presented by Dr. J. W. S. Macfie. (12) Several nymphs from liver of cattle : Accra, Gold Coast, 21.1.21 ; collected and presented by Dr. J. W. S. Macfie. (13) Very numerous adult specimens from a hedgehog : Accra, West Africa, 1.12.22 ; collected and presented by Dr. J. W. S. Macfie. (14) One adult female specimen measuring 80 mm. in length from lung of *Bitis masicornis*, Kumasi. (15) Three very large females from intestine of a horned *Cerastes*, Kumasi ; presented by Dr. Tweedy.

Genus *Waddycephalus*, Sambon, 1922.

Synonyms :—*Pentastoma*, Baird, 1862.
Pentastomum, Spencer, 1898.
Porocephalus, Shipley, 1898.

Diagnosis.—Porocephalini :

' Body club-shaped (like Australian " waddy "), tapering considerably towards posterior extremity, which ends in bilobed segment. Annuli smooth. Cephalothorax somewhat rounded, owing to constriction of anterior body segments. Hooks simple, unequal, inner larger, outer smaller, placed in arcuate line, the outer not only above the inner, but somewhat laterally. Mouth cordate, placed on inner hook-line. Anus between terminal lobes. Female genital opening considerably anterior to anus, placed on eighth body ring in *W. teretiusculus*. Alimentary canal axial, coils of utero-vagina amassed beneath alimentary canal.

' One species only described by Baird, in 1860, and again more fully by Spencer in 1893. Found in Australian snakes.'

Key to Species of the Genus Waddycephalus.

	Length	Annuli	Pore
W. teretiusculus	... 60 mm. × 5 mm.	Female 65 to 76 (50 to 70 Hett) Male 88 (60 Hett).	On 8th ring from anus
W. mazzai	?	41 to 44	On 3rd ring from anus.

Waddycephalus mazzai, Sambon, 1922.

Synonym :—*Pentastomum moniliforme*, Mazza, 1898.

Several adult female specimens from a snake, species unknown : Hong Kong ; presented by Dr. Bell.

Two species of this genus are known, viz., *W. teretiusculus*, found in the lungs of Australian snakes and *W. mazzai*, the host of which is unknown.

The specimens from Hong Kong agree in detail with the descriptions of *W. mazzai*.

Section III. *Linguatulini*, Sambon, 1922.

Diagnosis.—Porocephalinae :

' Body flattened fluke-like, more or less convex in middle part of dorsal surface, sides depressed. Hooks disposed archwise. Alimentary canal axial. Utero-vagina twines around it.

' Type genus : *Linguatula*, Frölich, 1789.'

Key to Genera of Section Linguatulini.

Body elliptical, flat ventrally, arched dorsally..... *Subtriquetra*
Body spatulate, attenuated posteriorly..... *Linguatula*

Genus *Subtriquetra*, Sambon, 1922.

Synonyms :—*Pentastoma*, Bresner, 1824.
Pentastomum, Diesing, 1850.
Linguatula, Railliet, 1883.

Diagnosis.—Linguatulini :

' Body more or less elliptical, flattened ventrally, greatly prominent dorsally. Adult form : Parasitic in crocodilians. Nymphal form : in fish.

'Type species : *Subtriquetra subtriquetra* (Diesing, 1835), Sambon, 1922.'

Key to Species of the Genus Subtriquetra.

Hooks simple..... *S. subtriquetra*
Hooks with subsidiary spines..... *S. megacephala*

The description of *Subtriquetra shipleyi*, Hett, 1924, is so meagre that it is impossible to distinguish it from *S. subtriquetra*.

Baird described the hooks of *S. megalocephala* as simple ; Sambon

states that they have accessory spines; but Hett, who examined the types, was unable to find accessory spines.

It has already been pointed out that it appears probable that *S. megacephala* is an intermediate form between the genera *Subtriquetra* and *Linguatula*. If Hett's opinion is correct, and it seems probable, then *S. megacephala* will have to be referred to the genus *Diesingia*, and the latter genus to the section *Linguatulini*, Sambon.

No specimens of this genus were found in the collections of the Liverpool School of Tropical Medicine.

Genus *Linguatula*, Frölich, 1789.

Synonyms :—*Taenia*, Pilger, 1803.
Halysis, Zeder, 1803.
Cochlus, Rudolphi, 1805.
Prionoderma, Rudolphi, 1808.
Polystoma, Rudolphi, 1809.
Echinorhynchus, Braun, 1809.
Tetragulus, Bosc., 1810.
Linguatula, Lamarck, 1816.
Pentastoma, Rudolphi, 1819.

Diagnosis.—Linguatulini :

'Body spatulate, attenuated posteriorly. Cephalothorax anteriorly obtuse. Mouth sub-terminal, squarish, situated between inner hooks. Hooks simple, equal, disposed archwise. Alimentary canal straight. Anus terminal. Uterus anteriorly twined round alimentary tube. Parasitic in mammals.

'Type species : *Linguatula serrata*, Frölich, 1789.'

Key to Species of the Genus Linguatula.

	Length	Posterior end
L. serrata	80 to 130 mm.	simple
L. recurvata	13 to 27 mm.	bifid and curved dorsally

Linguatula serrata, Frölich, 1789.

Synonyms :—Adult form.—*Ténia lancéolé*, Chabert, 1787.
Ver rhinaire, Chabert, 1787.
Taenia rhinaris, Pilger, 1803.
Taenia lanceolata, Rudolphi, 1805.
Cochlus rhinarius, Rudolphi, 1805.
Prionoderma rhinarium, Rudolphi, 1808.
Polystoma taenioides, Rudolphi, 1809.
Taenia rhinaria, Rudolphi, 1810.
Linguatula taenioides, Lamarck, 1816.
Prionoderma lanceolata, Cuvier 1817.
Pentastoma taenioides, Rudolphi, 1819.
Linguatula lanceolata, de Blainville, 1828.
Linguatula rhinaria, Railliet, 1900.

Nymph : *Linguatula serrata*, Frölich, 1789.
Taenia capraea, Abildgaard, 1789.
Taenia caprina, Gmelin, 1800.
Polystoma serratum, Goeze, 1803.
Halysis caprina, Zeder, 1803.
Linguatula denticulata, Rudolphi, 1805.
Echinorhynchus caprae, Braun, 1809.
Polystoma denticulatum, Rudolphi, 1809.
Tetragulus caviae, Bosc., 1810.
Pentastoma denticulatum, Rudolphi, 1819.
Pentastoma serratum, Rudolphi, 1819.
Pentastoma emarginatum, Rudolphi, 1819.
Pentastoma fera, Creplin, 1829.
Pentastoma taenoides, Dick, 1840 (misprint).
Linguatula ferox, Gros, 1849.
Linguatula caprina, R. Blanchard, 1895.
Linguatula rhinaris, Railliet, 1900.

(1) One specimen from a dog's nose ; presented by Captain Carter, I.M.S., India. (2) A number of nymphs from the liver of a male bushbuck (*Tragelaphus scriptus*) : Upper Shire, Nyasaland ; collected and presented by Professor R. Newstead, F.R.S., and Dr. Davey ; 1911. (3) One specimen from the nose of a dog : Manchester, England ; lent by A. W. Noel Pillers, Esq., F.R.C.V.S., D.V.S.M. Mr. Pillers states that he has only obtained this parasite twice in twenty years in England, once as noted above, and a second specimen from the nasal cavity of an otter hound in Shropshire.

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